Letters to the Editor.

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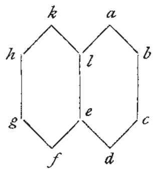
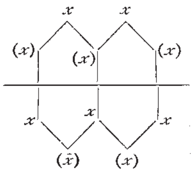
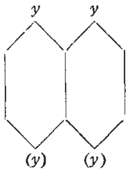
The Atomic Vibrations in the Molecules of Benzenoid Substances.

SIR WILLIAM BRAGG has recently suggested (Presidential Address to the Physical Society, Proc. Phys. Soc., 1921, 34, 33) that in the molecule of crystallised naphthalene the carbon atoms are arranged so that in the accompanying figure the centres of atoms at *h, l, b, g, e, c* lie in a plane, whilst those at *k* and *a* lie above the plane and those at *f* and *d* an equal distance below it.



If this were the normal stable arrangement in naphthalene and its simple derivatives, enantiomorphism would result in the case of all mono-substituted, and in the majority of the higher substituted compounds, the special examples of symmetry being obvious on inspection. Since, however, all the available evidence tends to show that the molecules of naphthalene derivatives are identical with their mirror images, it follows that the structure suggested by Sir William Bragg represents a phase of an oscillation of the relatively unrestricted molecules of the fused or dissolved substance in which the pairs of carbon atoms *k, a* and *f, d* appear alternately above and below the plane containing the six remaining atoms. At the first glance such a process appears peculiar and unsymmetrical, but this objection disappears when it is noticed that an identical result is obtained if all the atoms are supposed to be in motion in such a way that adjacent atoms move in opposite directions and to an equal distance from the plane of the original ring. If the component perpendicular to the plane of the ring is x, then the condition arrived at is shown below, x and (x) signifying, respectively, above and below the plane of the ring.





By rotating about the axis figured, the second position is obtained with six atoms in the plane of the original ring and four arranged as indicated ($y > x$ and $< 2x$). A similar vibration of the phenanthrene molecule would demand in the case of an isolated phase that the atoms lie in two planes parallel with that of the original ring, and also in four parallel planes containing carbon atoms to the number of two, six, five, and one, respectively. The above argument is circular to the extent that the naphthalene configuration was partly derived by analogy with the hexagonal rings of the graphite layers, but the point is that if independent evidence is forthcoming that an individual naphthalene molecule in a crystal has the arrangement of atoms put forward by Sir William Bragg, then at the same time at least one mode of vibration of the benzenoid molecules will be clearly indicated.

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Transport of Organic Substances in Plants.

IN a letter in NATURE of February 23, p. 236, under the above title, Prof. H. H. Dixon and Mr. N. G. Ball put forward the view that the wood of the vascular bundles provides the main path for the removal of the organic materials formed in foliage leaves to places of storage or conversion, the structure, form, and arrangement of the bast (phloem) being regarded as precluding any important longitudinal transmission within it.

I venture to doubt if the view that the phloem may serve as an important carbohydrate-conducting tissue merits such summary dismissal as the writers of the letter would appear to suggest.

In the first place, it is somewhat misleading to state that this belief . . . "seems to be based entirely on ringing experiments," unless this statement is intended to apply only to the "older writers." In an article on the Translocation of Carbohydrates (*Science Progress*, October 1910, January 1911) I attempted to bring together the available evidence from anatomical and experimental studies, and a perusal of that paper should show the wider basis for the view put forward by Czapek in 1897 that the phloem is to be regarded as the chief tissue concerned in the conduction of organic material in the plant. In later papers (*Annals of Botany*, 1915, 1917) I dealt with many of the points which call for consideration in any investigation of this problem, and indicated the nature of results obtained by the application of Senft's method of locating sugars by the formation of their osazones. Unfortunately, the war and the heavy pressure of departmental duties have held up the work, and it has not yet been possible to publish results in detail.

The following comments may be made, however, in connection with the view put forward by Prof. Dixon and his collaborator. The sugars are described as having to traverse the cross-partitions (of phloem cells) as a stream if they use this tissue as a conduit. It may be doubted whether the movement can be compared to the mass movement of water in a tube, and other considerations have been urged in the later paper referred to above.

Experiments made by Czapek (referred to in my last paper, pp. 293, 294, 303) showed that removal of starch from an attached leaf continued if a short length of the petiole was plasmolysed (but not killed), that a killed (boiled) portion of petiole prevented translocation permanently, but that a narcotised portion only temporarily interrupted the process, which was renewed on recovery of the tissues. Though perhaps not altogether excluding the possibility of conduction in the wood, such experiments appear to point to the activity of living cells in the transportation, and I have suggested a possible explanation of the continuance of the process in plasmolysed (living) cells, assuming the sieve-tubes to be the channels concerned (*loc. cit.*, p. 303).

Various histological features of sieve-tubes and their associated cells appear to harmonise well with the view that they serve to conduct carbohydrates, *e.g.* their continuity, distribution, and degree of development in different types of plants, the structure of the sieve-plate, the distribution of connecting-

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threads, the relation of sieve-tubes in the parasite Cuscuta to those of its host, etc.

A particularly interesting piece of evidence in favour of the phloem view is to be found in a paper by Schneider-Orelli on a leaf miner of the apple (*Centralb. f. Bakt.*, II Abt., 1909, 24, p. 158; cited by Schroeder, *Zeitschr. f. Bot.*, 1911, pp. 770-71). Where the caterpillar had bored through strong veins the destruction of the tissue affected the storage of starch in the leaf. It was found that the destruction of the xylem and the greater part of the bundle sheath could be brought about without causing an accumulation of starch in the distal part of the leaf (by interrupting the conducting channels), but that injury to the phloem resulted in an accumulation of starch proportional to the extent of the injury. Similarly, it has been found by Quanjer and others that the phloem necrosis associated with the leaf-curl of potatoes interferes with the transport of starch from the leaf, with the result that the tubers fail to develop properly.

It may also be noted that in a paper on the biology of a species of Aphis, Davidson (*Annals of Applied Biology*, v. 1921, p. 60) states that the phloem of the vascular bundles is especially sought for by these insects when tapping the plant for nutriment, and that this point is undergoing further investigation.

Although the case of Lepidodendron undoubtedly presents difficulties (a possible solution was suggested by me, *loc. cit.*, pp. 307-9), the difficulties are scarcely less on Prof. Dixon's view in the case of various aquatic plants which normally produce no xylem or only discontinuous traces.

I look forward with very great interest to the results of the work which Prof. Dixon and Mr. Ball have in hand, as the problem is a long-standing one. An urgent need is for more data on which to elaborate a theory of translocation in general.

SYDNEY MANGHAM.

Botanical Department, University College,
Southampton, March 28.

Pricked Letters and Ultimate Ratios.

IT is the purpose of this note to point out an earlier use of "pricked letters" to denote infinitesimals and of the phrase "prime and ultimate ratios" than is recorded in our histories of mathematics.

It will be recalled to mind that as early as 1665 Isaac Newton used "pricked letters" to denote fluxions or velocities. He did not permit his notation to appear in print before 1693. Between 1693 and 1704 the dot came to be used by other English writers, but nearly all of them departed from Newton in interpreting $\dot{x}$ to mean, not a velocity, but an infinitely small quantity or increment, like the Leibnizian *dx*.

Recently the present writer has noticed that as early as 1668 Nicholas Mercator used the dot to mark an infinitesimal, in an article in the Philosophical Transactions,[1] which contains illustrations of his "Logarithmotechnia" of 1668. Mercator uses in his article the letter I with a dot over it to indicate an infinitesimal difference.[2] This date, 1668, marks the earliest use of the dot for this purpose known to us. It was long before Newton allowed any part of his fluxions to appear in print and before Leibniz began to develop his calculus. Mercator could not have regarded the dot simply as part of the letter I, for (though the type is not quite clear) it appears to have been the capital letter. Moreover, in computing logarithms he writes the dot over a number (64, for example), to serve as a reminder that 64 is the coefficient of a power of an infinitesimal.

In the same article Mercator used a terminology[3] resembling the famous phrase "prime and ultimate ratios," used by Newton in his "Principia," 1687 (Bk. i. Sec. i. Lem. xi., Scholium). Mercator writes "ratiunculae" or little ratios, while Newton uses "rationes" or ratios. Mercator says "primae et ultimae ratiuncularum," Newton speaks of "rationes primae," and "rationes ultimae." We observe also that in 1695 Edmund Halley (Phil. Trans.) used "ratiuncula," and that in 1706 William Jones ("Synopsis Palmariorum," p. 174) made the statement: "Let $\dot{x}$ be a Ratiuncula or Fluxion of the ratio 1 to $1+x$."

It appears on the surface as if there had been a giving and receiving. In his letter to Oldenburg, dated October 24, 1676, Newton mentions Mercator's "Logarithmotechnia," but he nowhere refers to Mercator's illustrative article from which we have quoted. That article is of minor importance. It is not reproduced in the abridged edition of the Philosophical Transactions, and is not mentioned in the biographical sketches of Nicholas Mercator that we have seen. Whether in private Newton had used the phrases "prime ratios" and "ultimate ratios" on or before 1668 we have no means of knowing. He first used them in print in 1687. For some years after 1660 Mercator lived in London, where he became a member of the Royal Society. Newton became a member in 1672. As Newton lived at Cambridge (except during the Plague, when he was in the country), the chances that Mercator received information of Newton's work through private channels are reduced. After 1669 both Mercator's "Logarithmotechnia" and his illustrative article were in print. It is therefore possible that Newton may have adopted the phrase "prime and ultimate ratios" from Mercator. Newton's dot-symbol antedates Mercator's.

FLORIAN CAJORI.

University of California, March 18.

Einstein's Aberration Experiment.

IN the *Sitzungsberichte* of the Berlin Academy of December 8 last, which has recently come to hand, Einstein describes an ingenious arrangement which he suggests might serve to decide between the

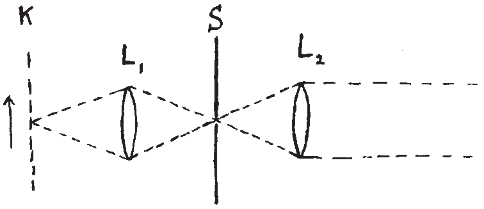

FIG. 1.

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[1] Phil. Trans., London, vol. 3, p. 759 ff. Reprinted in Maseres, *Scriptores Logarithmici*, vol. 1, p. 231.

[2] The passage in question relates to the use of the infinite series for finding $\log(1 \pm \dot{I})$ and is as follows: "Quare posito maximo termino $= 1$, et parte infinitissima (sic) differentiae $= \dot{I}$, et mensura rationis minimae itidem $\dot{I}$." He gives proportions like the following:

$$\text{“}1-\dot{I} \,.\, 1 :: \dot{I} \,.\, \dot{I}+\dot{I}\dot{I}+\dot{I}^3+\dot{I}^4, \text{ etc.”}$$

Here the fourth term of the proportion is an infinite series; ratio is indicated by (.) placed at the lower edge of the line.

[3] The passage in Mercator is, " . . . non nisi semisse primae et ultimae ratiuncularum a prioribus terminis contentarum, id est, ratiuncula minori, quam quae ullis numeris exprimi possit."

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